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12 January 2005

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PATENT & TRADEMARK OFFICE

Dear Sir,

SUBMISSION OF PRIORITY DOCUMENTS

Application Serial Number: 10/765,032
Confirmation Number: 9592
Art Unit: 3746
Applicant: Jamieson Edward CHAMP, et al.
Our File Ref: 407-90US

We now submit the certified copies of the priority documents in respect of the above patent application.

Submitted by,

Anthony Asquith
(Regn 32373)
Agent for the Applicant
Customer # 23716

Enclo:
Certified Copies GB-0301936.1
GB-0319262.2

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The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

[illegible] the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) [illegible] the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the [illegible]mptroller-General, hereby certify that annexed hereto is a true copy of the documents as [illegible]inally filed in connection with the patent application identified therein.

[illegible]cordance with the Patents (Companies Re-registration) Rules 1982, if a company named i[illegible] certificate and any accompanying documents has re-registered under the Companies Act [illegible] with the same name as that with which it was registered immediately before re-re[illegible]ation save for the substitution as, or inclusion as, the last part of the name of the words "p[illegible] limited company" or their equivalents in Welsh, references to the name of the company in [illegible]ertificate and any accompanying documents shall be treated as references to the name wi[illegible]ich it is so re-registered.

In a[illegible]nce with the rules, the words "public limited company" may be replaced by p.l.c., plc, [illegible]C. or PLC.

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Signed

Dated 28 June 2004

CERTIFIED COPY OF PRIORITY DOCUMENT

N.W.I.C

Patents Form 1/77

Patents Act 1977
(Rule 16)

The Patent Office

29JAN03 E780503-4 C10121
P01/7700 0.00-0301936.1

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference — 4C7-SSC.B

2. Patent application number *(The Patent Office will fill in this part)* — 0301936.1

3. Full name, address and postcode of the or of each applicant *(underline all surnames)* — SOLINST CANADA LTD. 35 TODD ROAD GEORGETOWN ONTARIO CANADA.

   Patents ADP number *(if you know it)* — 05783466002

   If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention — BLADDER PUMP FOR BOREHOLE SAMPLING.

5. Name of your agent *(if you have one)* — ANTHONY ASQUITH. 325 LEEDS ROAD. SCHOLES LEEDS LS15 4DD.

   "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

   Patents ADP number *(if you know it)*

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
   a) any applicant named in part 3 is not an inventor, or
   b) there is an inventor who is not named as an applicant, or
   c) any named applicant is a corporate body.
   See note (d))

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	6
Claim(s)	
Abstract	
Drawing(s)	6

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature Date

12. Name and daytime telephone number of person to contact in the United Kingdom

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Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.*

b) *Write your answers in capital letters using black ink or you may type them.*

c) *If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.*

d) *If you have answered 'Yes' Patents Form 7/77 will need to be filed.*

e) *Once you have filled in the form you must remember to sign and date it.*

f) *For details of the fee and ways to pay please contact the Patent Office.*

Title: BLADDER PUMP FOR BOREHOLE SAMPLING

[001] The concept of a bladder pump is simply to deliver a fluid sample through a gas drive (or gas lift) process while not allowing the fluid sample to come into contact with the drive gas. Pumping is generally accomplished by allowing the bladder to fill under hydrostatic pressure and then introducing a drive gas, closing the bottom check valve and compressing the bladder. The compression of the bladder forces the sampled fluid past a second check valve and into the sample tubing. When the drive annulus is subsequently vented, the bottom check valve opens and again the pump fills under hydrostatic pressure. The check valve at the bottom of the sample tubing prevents the slug of fluid from falling back into the pump while it is filling.

[002] The technology of bladder pumps is generally known. The bladder traditionally comprises a length of thin-walled plastic tubing, which is so flimsy that the tubing can readily expand and collapse. One of the key aspects with which the designer must be concerned is the manner by the bladder is to be attached to the stems of its hard (metal or plastic) end fittings. The manner of attachment must be secure against mechanical forces tending to pull the bladder off the stem, and yet also the attachment must be done without stressing the thin flimsy plastic material to tear, and causing it to tear.

[003] The advent of smaller boreholes and sampling locations indicated a requirement for a small bladder pump to fit these applications. In an effort to maintain similar volumes and flow rates while reducing the diameter of the pump, it became necessary to increase the length of the pump accordingly. In order for a small diameter pump of a length necessary for reasonable flow to be dropped to reasonable depths in small holes (most sampling holes are not perfectly straight), it became apparent that the pump itself would have to be flexible.

[004] It has been traditional, in bladder pumps, for a spine to be included inside the bladder, to keep the bladder to its shape and prevent it collapsing. The new design as described herein reduces the need for such a spine. It has also been traditional, in bladder pumps, for the bladder to be used inside an outer tube of rigid material (metal or plastic). The new design as described lends itself to use in cases where the outer tube surrounding the bladder is itself flexible. (That is to say, the outer tube is more flexible than has traditionally been the case with outer tubes - of course, the outer tube still has to be much more rigid than the flimsy bladder.)

GENERAL FEATURES OF THE INVENTION

[005] The new invention aims to provide a way of securing a flimsy bladder around and to a rigid stem. The new invention makes use of a spring, i.e a helical or coil spring; the bladder tube fits over the stem, and then the spring fits over the wall of the tube, and the spring compresses the wall of the tube onto the stem. It has been found that a bladder tube secured in this manner can resist high pressures, and has little tendency to become torn at the point of attachment, even though subjected to frequent flexure.

[006] The spring clamps at each end of the flexible bladder are fabricated from small diameter stainless steel extension springs. The bladder termination itself is a small stem or mandrel onto which a helix is cut. The pitch of the helix is cut slightly larger than the spring for a resultant preload of the spring during assembly.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[007] By way of further explanation of the invention, exemplary embodiments of the invention will now be described with reference to the accompanying drawings, in which:

Fig 1 shows a length of bladder tube for a bladder pump, about to be secured to an end fitting, in the manner of the invention.

Fig 2 is the same as Fig 1, but shows the components at a later stage of securement.

Fig 3 is the same as Fig 1, but at a still later stage.

Fig 4 shows the completed attachment of the bladder tube to the fitting.

Fig 5 shows a completed bladder.

Fig 6 shows an upper check valve assembled into the bladder pump.

Fig 7 shows a manifold located at the ground, for use in operating the pump.

[008] The apparatuses shown in the accompanying drawings and described below are examples which embody the invention. It should be noted that the scope of the invention is defined by the accompanying claims, and not necessarily by specific features of exemplary embodiments.

[009] To assemble the bladder retention system the bladder tube 20 is first folded in such a manner as to allow the helical coil spring 23 to pass over and along the tube, to a position approximately 1" from the end of the tube. This condition is shown in Fig 1. The bladder tube 20 is of thin-walled (e.g 0.005" wall thickness) heat-shrinkable polytetrafluoroethylene (ptfe).

[0010] The stem 24 of the (stainless steel) upper end-fitting 25 is formed with a shallow helical groove 26. The groove is e.g 0.01" deep. The groove profile is gently rounded, such that the wall of the bladder

tube, upon being squeezed into intimate touching contact with the stem, leaves no gaps in the profile.

[0011] The open end 27 of the bladder tube 20 is placed over the stem 24. The bladder tube is heated, whereupon the ptfe material shrinks, such that, over a heat-shrunk area 28, the bladder tube now conforms to, and grips lightly around, the stem 24, being the condition as shown in Fig 2. The spring 23 is drawn forwards, over the heat-shrunk area 28, and threaded over the stem 24. The dimensions of the components is such that the spring 23 has to be expanded slightly in order for the spring to be screwed onto the groove 26, over the thickness of the ptfe material. The result is as shown in Fig 3. This operation can be carried out by a person, by the use of the fingers, although the assembly may be automated.

[0012] Heat-shrunk thin-walled ptfe tubing can be held very securely to the stem of the end-fitting by this technique. The manner of securement imposes very little stress-concentration in the flimsy bladder material, although care should be taken to ensure that particularly the end of the stem is smooth and rounded. The manner of securement has been found to be mechanically strong, and more than adequate both against forces tending to pull the bladder tube axially off the stem, and against pressure forces, internally and externally of the bladder. It is noted that, in use for extracting samples from boreholes, the bladder may be subjected to a pressure differential in which the pressure outside the bladder exceeds the pressure inside by around xxx, and a differential in which the pressure inside exceeds the pressure outside by xxx.

[0013] The other end of the bladder tube 20 is secured to the stem 29 of the bottom end fitting 30 by the same technique.

[0014] As shown in Fig 4, the assembled bladder 32 is placed inside an outer pump tube 34. The outer pump tube 34 is of thick-walled polyethylene or ptfe, having a wall thickness of around 0.06". The tube 34 is self-supporting, being much thicker and stiffer than the (flimsy) bladder tube 20. Such plastic tubing is flexible, however, in the sense that the tubing can be bent to a (gentle) arc, which is what is needed if the bladder pump is to be fed through tight narrow clearances -- given that drilled boreholes in the ground and the pipes and tubes used therein are usually not quite straight. The plastic outer pump tube 34, however, is not flexible in the sense of resistance to pressure, i.e in the sense of resistance to hoop or circumferential stresses.

[0015] In an alternative installation, where clearances might not be so tight, the outer tube can be made of metal or more rigid plastic.

[0016] The bottom end fitting 30 of the bladder 32 includes the barbed

stem 29, to which the lower end of the pump outer tube 34 is secured. The bottom end fitting 30 includes a check valve 35, in the form of a (stainless steel) ball 36, which settles against a seat 37 if pressurised from above, and allows fluid to pass through the fitting 30 if pressurised from below.

[0017] The upper end fitting 25 of the bladder includes a long-tube 38, which fits inside the central bore 39 of an outer adapter piece 40. The long-tube 38 is a loose or floating fit inside the adapter 40, and is not attached to the adapter. A shoulder 42 on the upper end fitting 25 limits the extent to which the long-tube 38 can travel upwards into the adapter 40. The shoulder 42 is angled to ensure that, even if the shoulder were in contact with the lower end of the adapter 40, fluid can pass freely, past the shoulder 42, around the long-tube 38, and through the bore 39.

[0018] The upper end of the long-tube 38 receives the sample transfer tube 43, which is a length of thick-walled polyethylene tubing that extends to the surface. The bottom end of the sample transfer tube 43 is fitted with a check-valve 45. As shown in Fig x, a collar 46 is first inserted into the bottom end of the sample transfer tube 43. This collar grips the tube 43 internally. Next, a loose valve member 47 is placed inside the tube 43. Finally, the sample transfer tube 43 is barbed to the upper end of the long-tube 38, trapping the valve member 47 inside. The valve member 47 is so shaped as to be able, upon being pressurised from above, to sink down onto the top 48 of the long-tube, and create a seal. Thus, the top 48 of the long-tube 38 provides a valve seating which interacts with the valve member 47. When pressurised from below, the valve member can contact the collar 46, but the collar is so shaped that the valve member cannot form a seal therewith.

[0019] In an alternative construction, the check valve is built into a housing that is screwed onto the top end of the long-tube. The sample transfer tube, in that case, is barbed to the upper end of the housing.

[0020] The sample transfer tube 43 being now barbed onto the long-tube 38, the down-hole portion of the pump assembly is completed by barbing outer tube 49 onto the upper end of the adapter piece 40 (Fig x). The outer tube 49 extends up to the surface.

[0021] At the surface, as shown in Fig x, a manifold 50 is provided. The sample transfer tube 43 passes right through the manifold, whereby the sample contained in the tube is transferred out through sampling port 52. The outer tube communicates with the drive port 53, through which the annular space 54 between the outer tube 49 and the sample transfer tube 43 can be pressurised (with gas). The annular space 54 communicates with the

space 56 between the bladder tube 20 and the pump outer tube 34. By pressurising this space 56 (i.e by pressurising the space 54, the bladder 32 can be made to collapse.

[0022] In use, the bladder pump is operated in the conventional manner. The drive port 53 is alternately pressurised and de-pressurised. When the space 56 is de-pressurised, the bottom check valve 35 opens and water from the borehole enters the bladder 32. The upper check valve 45 opens as the pressure in the sample transfer tube 43 is lower than the borehole pressure of the sample of water entering the bladder. Then, the space 56 is pressurised, which causes the bladder to collapse. The bottom check valve 35 closes, and the upper check valve 45 opens, and the sample is pumped out of the bladder, upwards into the sample transfer tube. Water can be pumped out of the borehole, through the sampling port 52, in a steady stream if desired.

[0023] It will be noted that the bladder 32 is mechanically attached to the pump outer tube 34 at the very bottom of the pump, and the sample transfer tube 43 is attached to the manifold 50 at the sampling port 52. Apart from those attachment points, the sub-assembly of the bladder 32 and the sample transfer tube 43 is free to float in the space inside the outer tubes 34,49 and inside the adapter 40. This free floating aspect is important in avoiding unpredictable stresses in the flimsy material of the bladder tube 20, and in permitting the pump, as an assembled structure, to be flexible enough to pass freely up and down the narrow and not-quite-straight passageways.

[0024] It has been found that, when the coil spring 23 is screwed onto the stem, trapping the ptfe tubing 20 therebetween, the tubing does not tend to become twisted. That is to say, the tubing remains fixed to the stem 24, and the spring rotates around the tubing. In fact, the tubing is so flimsy that, if the tendency were for the tubing to be dragged around with the spring, not much could be done e.g by way of gripping the tubing, to resist that tendency. Assembly of the bladder itself is simple enough, at least as a manual operation, in that the bladder (i.e the bladder tube and its two end fittings) is completed as a unit before the bladder is assembled into the outer tube. Of course, some care is needed when carrying out assembly work on the bladder, as it is all too easy to damage the thin-walled tubing.

[0025] The problem of attaching a flimsy tube to a stem, in a manner that leaves the attachment mechanically strong, and pressure-resistant, is exacerbated when the overall diameter of the tube is very small. In the case as depicted in the drawings, the ptfe heat-shrinkable tubing from which the bladder is made is 1/4" in diameter. The stem onto which the heat-shrunk end of the bladder tube is secured is nominally 3/16" diameter.

The spring is made of round wire, of 1/32" diameter, and is about seven coils in length. It is wound to a helix of such diameter that, if the bladder tube were not present, the spring would just about slide axially over and along the stem.

[0026] Attaching a 1/4" diameter ptfe tube to a stem, in a manner which leaves the attachment able to resist quite high pressures, and to resist continual flexing of the tube wall, is a difficult problem. Properly serviceable bladder pumps are readily available in sizes above about 3/4" bladder diameter, but traditionally, below that diameter, the pumps that have been available have been notoriously fragile, and prone to leakage and other problems. The manner of attaching the bladder as described herein may be expected to alleviate the robustness problems.

[0027] The reduced diameter of the pump of course means that, in order to achieve good sample volumes, the bladder must be quite long. Thus, where a 3/4" bladder in a larger bladder pump may be say two feet long, the 1/4" bladder is preferably at least four feet long. The long length of the bladder means that the difference between the inside/outside pressure differential at the top of the bladder can be a significantly larger than the differential at the bottom of the bladder. Thus, the bladder in a long, small-diameter pump is called upon to support greater differentials than the bladder in a shorter, larger-diameter pump. Even so, the manner of attachment as described herein is more than adequately equal to the task.

[0028] In the larger diameters of bladder, the task of screwing a coil spring over tubing, over a stem, becomes a little more difficult, and, as mentioned, traditional ways of attaching thin-walled tubes to stems are acceptable when the diameter is large. However, the technique of the screwed-on coil spring over heat-shrunk tubing, as described, may be used in the larger diameters.

[0029] Because of the small volume of a small-diameter bladder, it can sometimes be a problem to extract samples at a high flowrate, where that is a requirement. In that case, several bladders may be provided. The several bladders are separately operated (by being pressurised from above), but all the bladders discharge into a common sample transfer tube leading to the surface. Several independent small-diameter bladder pumps can be more flexible, and easier to lower down to deep depths, than one large-diameter pump.

Anthony Asquith
Agent for the Applicant
Docket: 407-88

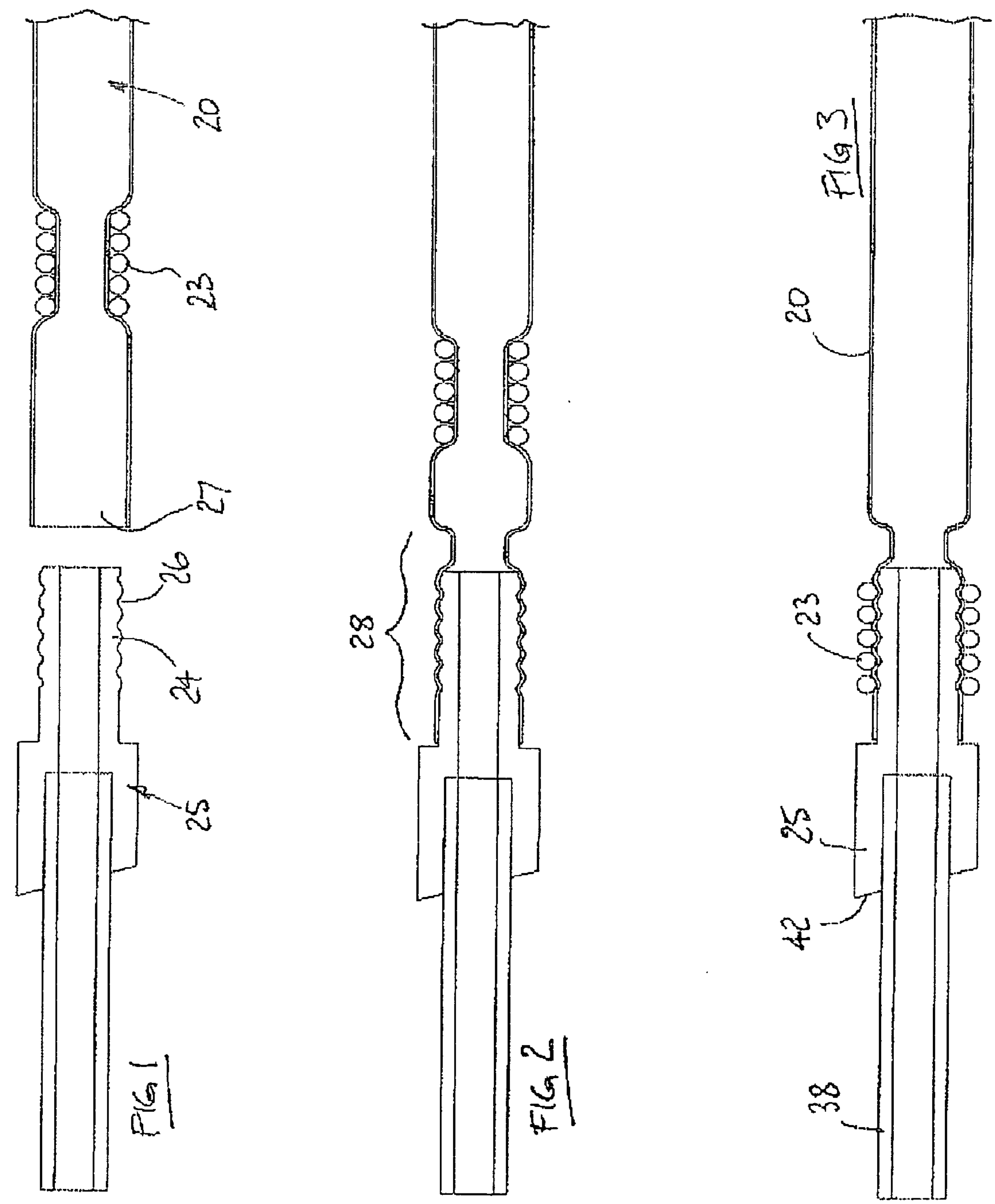
20
23
27
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FIG 1
28
FIG 2
FIG 3
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38

REV.	E.C.N.	DESCRIPTION	DATE
A	–	RELEASE	

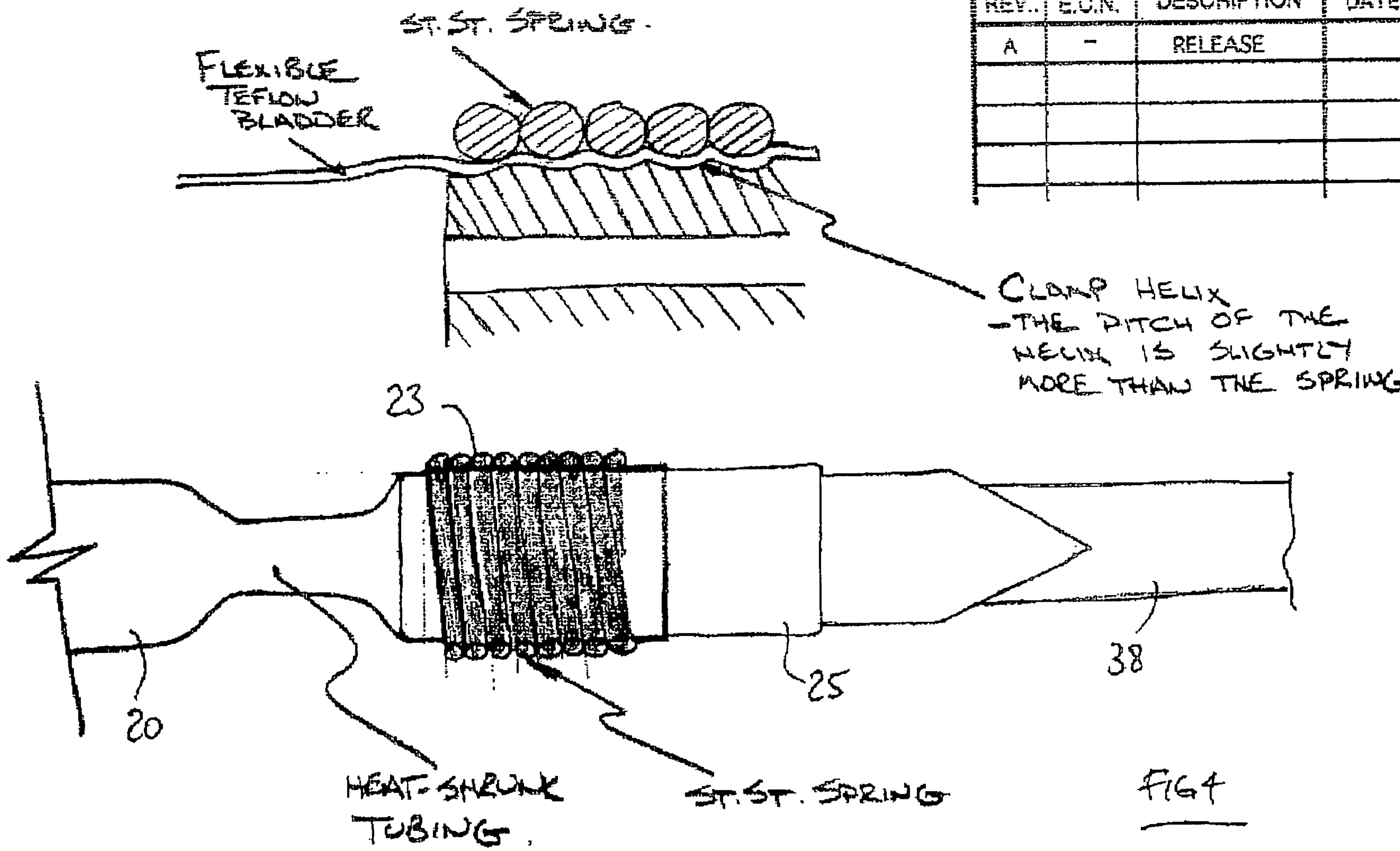

FIG4

Tolerances .XXX +/-.003" .XX +/-.010" .X +/-.020" Fractional +/- 1/64" Angles +/- 30'	Solinst Groundwater Monitoring Instrumentation Fax (905) 873-1992 Tel (905) 873-2255 or (800) 661-2023 35 Todd Road, Georgetown, ON, Canada L7G 4R8	Scale:	Date: JAN. 21, 2003
		Drawn: J. CHAMP	Approved:
		Checked:	
		MATERIAL: AS SHOWN	

TITLE: SPRING CLAMP DETAIL	
Finish:	
DRAWING NO. X403.4	REV. A

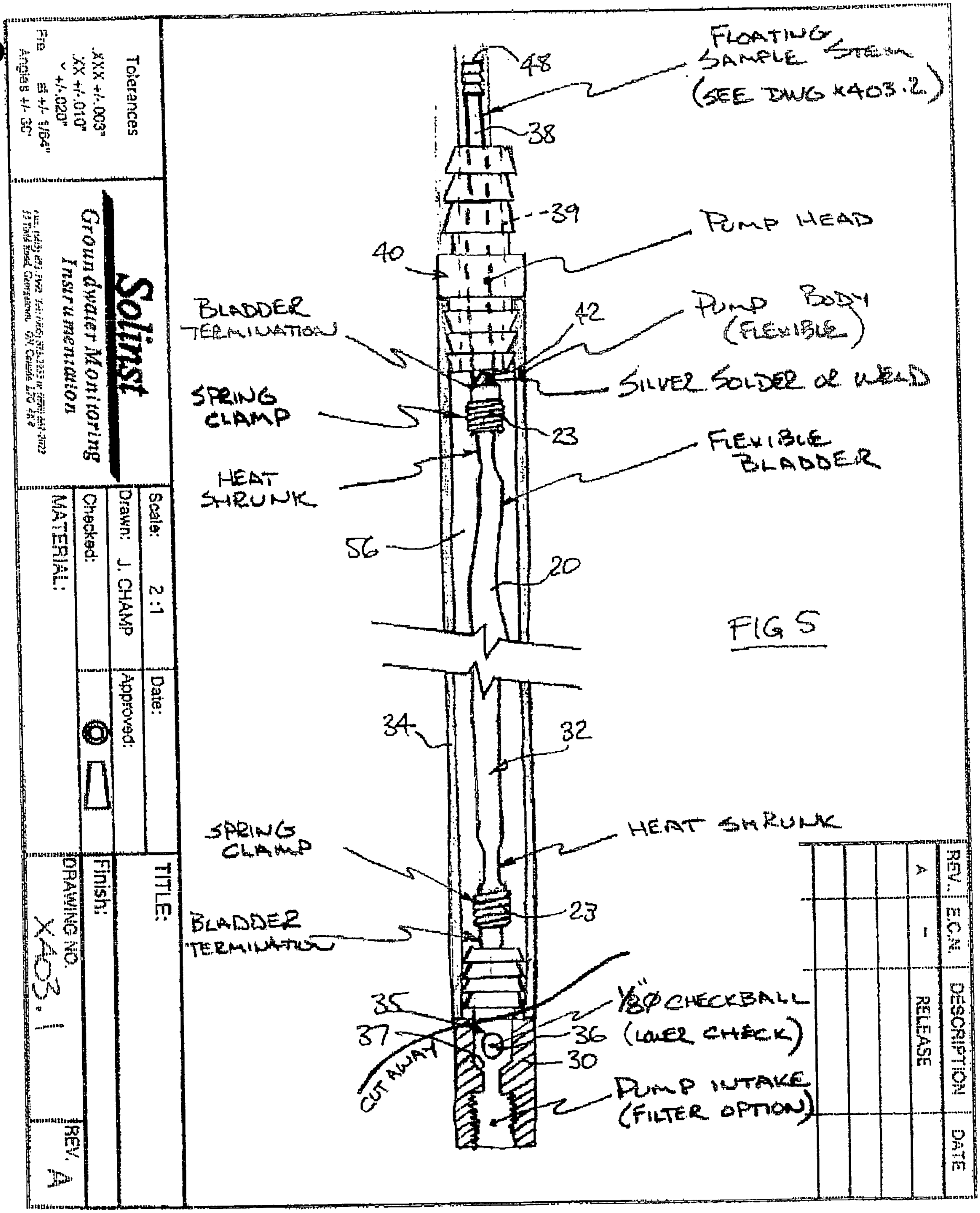

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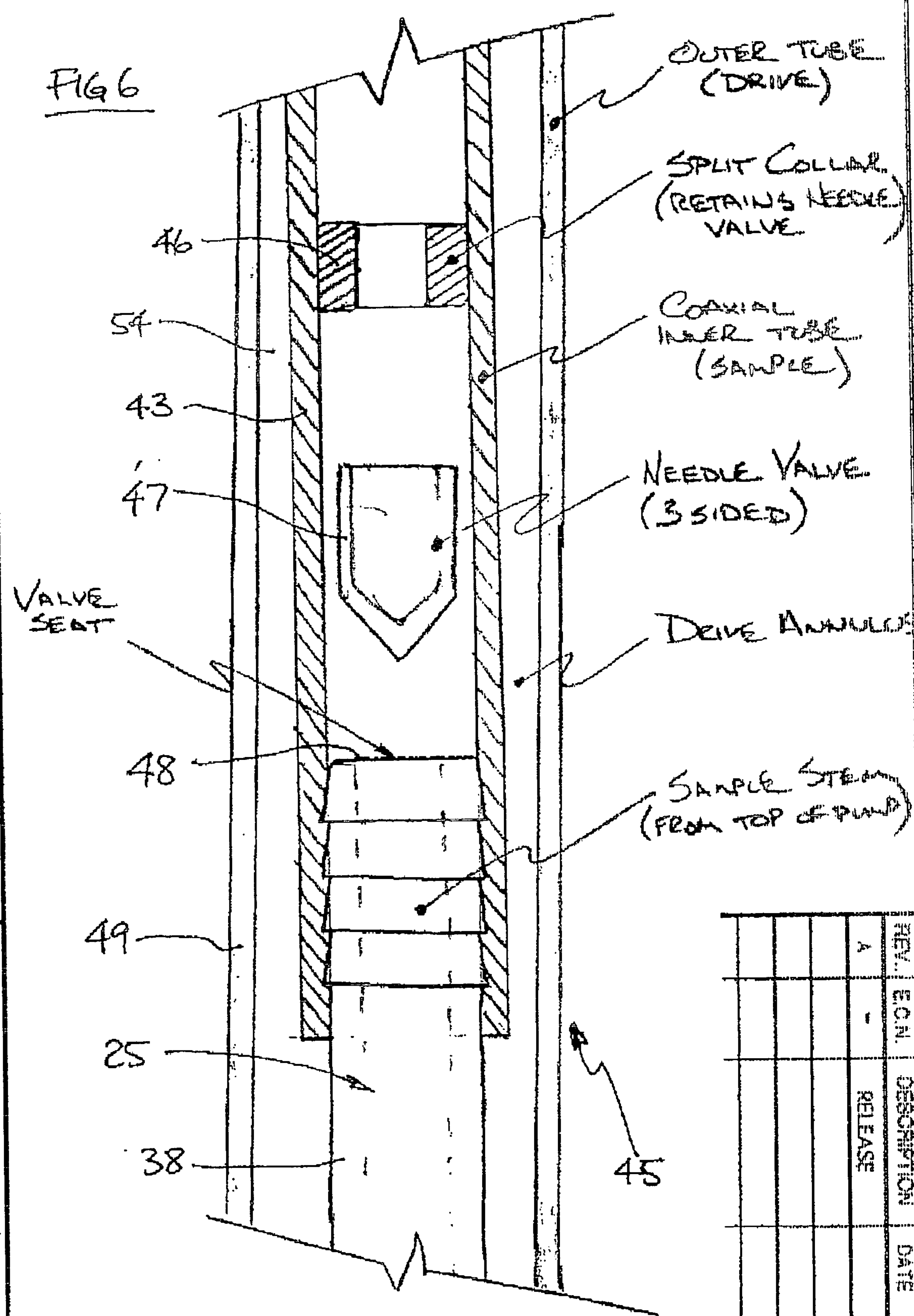
FIG 6

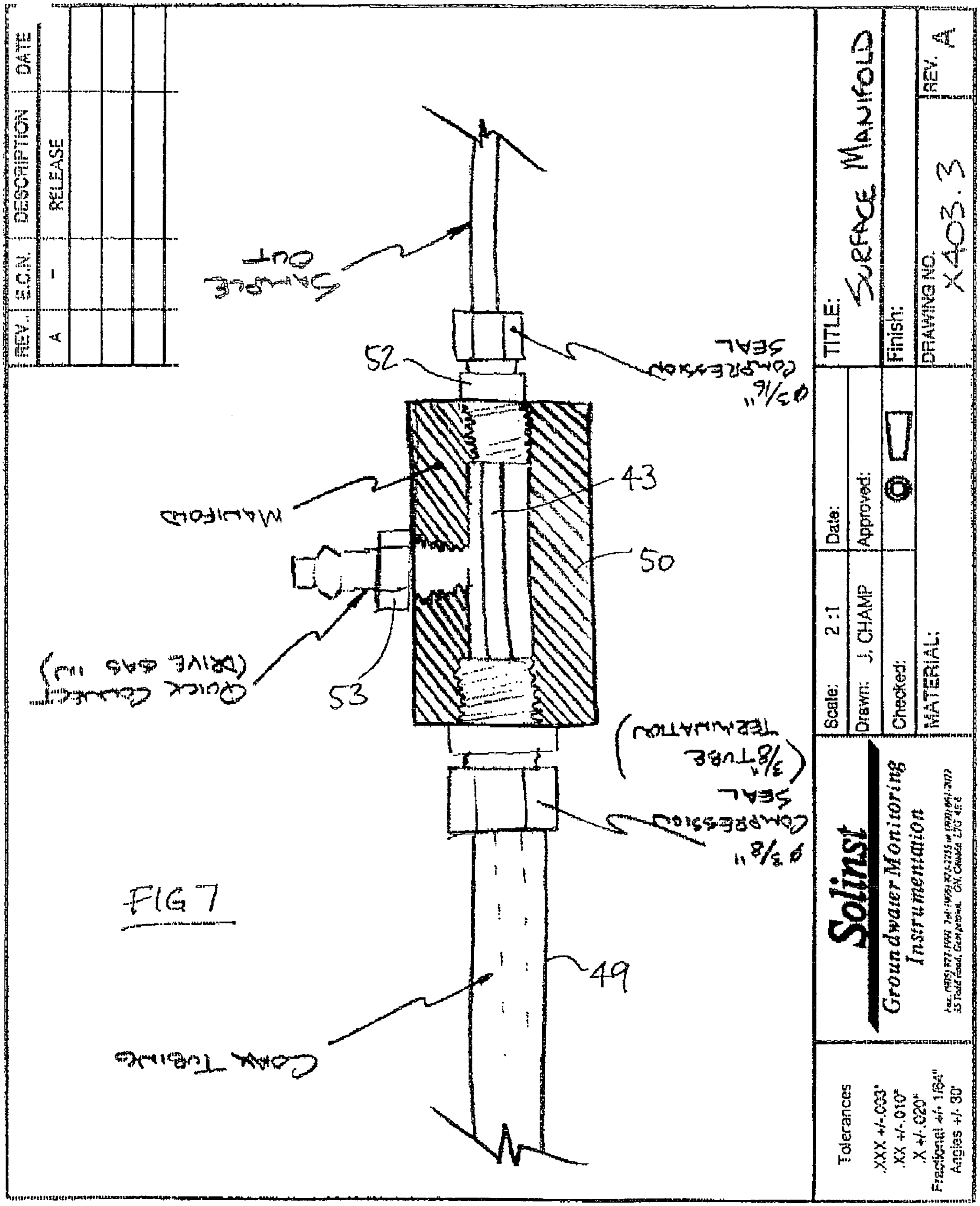


Tolerances
.XXX +/-.003"
.XX +/-.010"
.X +/-.020"
Frac" +/- 1/64"
∠ +/- .5°

Solinst
Groundwater Monitoring Instrumentation

Scale:
Drawn: J. CHAMP
Checked:
MATERIAL: AS SHOWN
Date: JAN. 21, 2003
Approved:
TITLE: TOP CHECK VALVE DETAIL
Finish:
DRAWING NO. X403.2
REV. A

REV.	E.C.N.	DESCRIPTION	DATE
A	-	RELEASE	


REV. | E.C.N. | DESCRIPTION | DATE
A | - | RELEASE
SAMPLE OUT
COMPRESSION SEAL
ø3/16"
52
MANIFOLD
43
50
QUICK CONNECT (DRIVE GAS IN)
53
ø3/8" COMPRESSION SEAL (3/8" TUBE TERMINATION)
FIG 7
49
COAX TUBING
TITLE: SURFACE MANIFOLD
Scale: 2:1
Date:
Drawn: J. CHAMP
Approved:
Checked:
Finish:
MATERIAL:
DRAWING NO. X403.3
REV. A
Solinst
Groundwater Monitoring Instrumentation
Tolerances
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.X +/-.020"
Fractional +/- 1/64"
Angles +/- 30'

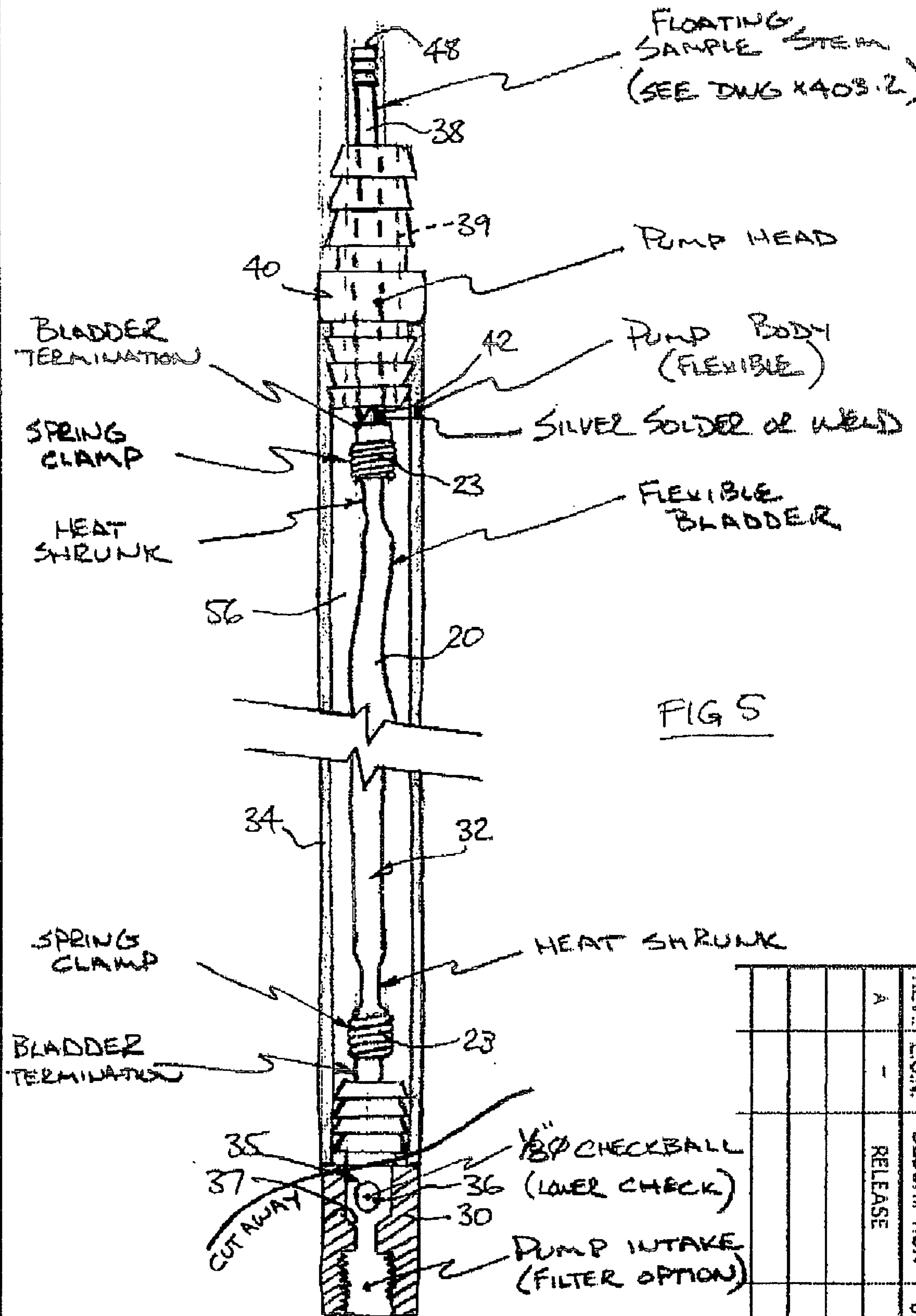

FIG 5

Tolerances
.XXX +/-.003"
.XX +/-.010"
.X +/-.020"
Frac +/- 1/64"
Ang .25 +/- .30'

Solinst
Groundwater Monitoring Instrumentation

Scale: 2:1
Drawn: J. CHAMP
Checked:
MATERIAL:
Date:
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Finish:
TITLE:
DRAWING NO. X403.1
REV. A

REV.	E.C.N.	DESCRIPTION	DATE
A	-	RELEASE	